

**Remarks:**

Please reconsider the application in view of the above amendments and the following remarks.

**Disposition of Claims**

Prior to this response, the application included claims 1-41. Examiner rejected claims 1-41, and objected to 11, 16, 29-31, and 34. Applicants acknowledge the Examiner's indication that claims 11, 16, 29-31, and 34, would be allowed if rewritten in independent form. However, Applicants maintain that the claims as originally drafted and currently amended are allowable over the rejections. Claims 18 and 21 have been amended to include the limitation "piezoelectric." Applicants have cancelled claims 35-41. Claims 1-34 are presented for examination.

**Rejections under 35 U.S.C. §§ 102, 103**

*Independent Claim 1*

The Examiner rejected independent claim 1 as anticipated under 35 U.S.C. 102 by Kusunoki et al. (U.S. 2004/0207671). Applicants respectfully submit that Kusunoki et al. fails to disclose applying a multipulse waveform...wherein a frequency of the drive pulses is greater than a natural frequency of the droplet ejection device as recited in independent claim 1. Rather, Kusunoki describes a waveform in the time domain by the following equation,

$$t_r + P_w + t_f + t_d = nxT_s$$

The equation describes a driving pulse with a rising time constant  $t_r$ , a pulse width  $P_w$ , a falling time constant  $t_f$ , and a pulse interval  $t_d$ , resonance period  $T_s$ , and  $n$  is an integer that is no less than 1. The sum of these waveform parameters ( $=t_r + P_w + t_f + t_d$ ) is set to be  $n$  times as large as the ink resonance period  $T_s$ . (paragraph [0117-0119]).

To find the resonant frequency, the equation must be converted from the time domain to the frequency domain. The resonant frequency  $f_s$  is equal to the inverse of the resonant period  $T_s$ ,  $f_s = 1/T_s$ . Taking the inverse of the Kusunoki equation in the time domain provides the Kusunoki equation in the frequency domain:

$$1/(t_r + P_w + t_f + t_d) = 1/(n \times T_s)$$

Since  $n$  is an integer no less than 1, the frequency of the waveform is equal to or less than the natural frequency. As  $n$  increase, the denominator gets larger causing the frequency of the waveform to decrease. Conversely, claim 1 recites a frequency of the drive pulses is greater than a natural frequency of the droplet ejection device.

Accordingly, Kusunoki does not anticipate claim 1 and Applicants respectfully request that the rejection be withdrawn. Furthermore, because claims 2-17 depend from claim 1, these dependent claims are not anticipated for at least the same reason that independent claim 1 is not anticipated.

#### *Independent Claim 18*

The Examiner rejected independent claim 18 as anticipated under 35 U.S.C 102 by Oikawa (U.S. 2002/0039117). Applicants have amended independent claim 18 to recite a “method comprising driving a piezoelectric droplet ejection device with a waveform comprising one or more pulses....” Oikawa fails to disclose a piezoelectric droplet ejection device as recited in amended independent 18. Rather, Oikawa describes an ink jet printing system with an electrothermal transducer to apply thermal energy to ink that creates a bubble and ejects an ink droplet. (paragraph [0003])

Accordingly, Applicants respectfully request that the rejection under 35 U.S.C. 102 be withdrawn. Furthermore, because claims 19 and 20 depend from claim 18, these dependent claims are not anticipated for at least the same reason that independent claim 18 is not anticipated.

#### *Independent Claim 21*

The Examiner rejected independent claim 18 as anticipated under 35 U.S.C 102 by Oikawa (U.S. 2002/0039117). Applicants have amended independent claim 21 to recite a “method comprising driving a piezoelectric droplet ejection device with a multipulse waveform comprising two or more pulses....” Oikawa fails to disclose a piezoelectric droplet ejection device as recited in amended independent 21. Rather, Oikawa describes an ink jet printing

20. (Original) The method of claim 19, wherein the one or more pulses each have a period less than about 10 microseconds.

21. (Currently amended) A method comprising driving a piezoelectric droplet ejection device with a multipulse waveform comprising two or more pulses each having a pulse period less than about 25 microseconds to cause the droplet ejection device to eject a single droplet in response to the two or more pulses.

22. (Original) The method of claim 21, wherein the two or more pulses each have pulse period less than about 12 microseconds.

23. (Original) The method of claim 21, wherein the two or more pulses each have pulse period less than about 8 microseconds.

24. (Original) The method of claim 21, wherein the two or more pulses each have pulse period less than about 5 microseconds.

25. (Original) The method of claim 21, wherein the droplet has a mass between about 1 picoliter and 100 picoliters.

26. (Original) The method of claim 21, wherein the droplet has a mass between about 5 picoliters and 200 picoliters.

27. (Original) The method of claim 21, wherein the droplet has a mass between about 50 picoliters and 1000 picoliters.

28. (Original) An apparatus, comprising:  
a droplet ejection device having a natural frequency  $f_j$ ; and  
drive electronics coupled to the droplet ejection device,  
wherein during operation the drive electronics drive the droplet ejection device with a

multipulse waveform comprising a plurality of drive pulses having a frequency greater than  $f_j$ .

29. (Original) The apparatus of claim 28, wherein the harmonic content of the plurality of drive pulses at  $f_j$  is less than about 50% of the harmonic content of the plurality of the drive pulses at  $f_{max}$ , the frequency of maximum content.

30. (Original) The apparatus of claim 29, wherein the harmonic content of the plurality of drive pulses at  $f_j$  is less than about 25% of the harmonic content of the plurality of the drive pulses at  $f_{max}$ .

31. (Original) The apparatus of claim 30, wherein the harmonic content of the plurality of drive pulses at  $f_j$  is less than about 10% of the harmonic content of the plurality of the drive pulses at  $f_{max}$ .

32. (Original) The apparatus of claim 28, wherein during operation the droplet ejection device ejects a single droplet in response to the plurality of pulses.

33. (Original) The apparatus of claim 28, wherein the droplet ejection device is an ink jet.

34. (Original) An ink jet printhead comprising the ink jet of claim 30.

35.-41. (Cancelled)

system with an electrothermal transducer to apply thermal energy to ink that creates a bubble and ejects an ink droplet. (paragraph [0003])

Accordingly, Applicants respectfully request that the rejection under 35 U.S.C. 102 be withdrawn. Furthermore, because claims 22-26 depend from claim 21, these dependent claims are not anticipated for at least the same reason that independent claim 21 is not anticipated.

The Examiner also rejected dependent claim 27 as being unpatentable under 35 U.S.C. 103 over Oikawa et al. The Examiner acknowledges that Oikawa fails to disclose the droplet has a mass between 50 picoliters and 1000 picoliters. The Examiner states that discovering optimum or workable ranges involves routine skill in the art. The Examiner states that since Oikawa discloses a 42 ng droplet mass, it would have been obvious to one having ordinary skill in the art at the time the invention was made to utilize a droplet mass between 50 picoliters and 1000 picoliters. Applicants submit however Oikawa fails to disclose a piezoelectric droplet ejection device as recited in independent claim 21. Since claim 27 depends from independent claim 21, claim 27 is not obvious for at least the same reason as claim 21.

Accordingly, Applicants respectfully request that rejection of claim 27 under 35 U.S.C. 103 be withdrawn.

#### *Independent Claim 28*

The Examiner rejected claim 28 as anticipated under 35 U.S.C. 102 by Akiyama et al. (U.S. 6,378,972). Applicants respectfully submit that Akiyama et al. fails to disclose a droplet ejection device having drive electronics...wherein during operation the drive electronics drive the droplet ejection device with a multipulse waveform comprising a plurality of drive pulses having a frequency greater than the natural frequency  $f_j$ . Rather, Akiyama describes nozzles with a Helmholtz natural oscillation frequency of about 100 kHz. (Col. 4, lines 31-33). Akiyama discloses driving an ink jet head at high frequencies of up to 25 kHz. (Col. 2, lines 55-60) Since 25 kHz is less than the Helmholtz natural oscillation frequency of 100 kHz, Akiyama describes driving an ink jet head at frequencies less than the Helmholtz natural oscillation. Akiyama does not disclose driving the ink jet head at frequencies above 100 kHz. Thus, Akiyama does not

disclose a multipulse waveform comprising a plurality of drive pulses have a frequency greater than the natural frequency.

Accordingly, Applicants respectfully request that the rejection under 35 U.S.C. 102 be withdrawn. Furthermore, because claims 29-34 depend from claim 28, these dependent claims are not anticipated for at least the same reason that independent claim 28 is not anticipated.

*Independent Claim 35*

Applicants respectfully disagree with the rejection of independent claim 35 and dependent claims 36-41 under 35 U.S.C. 103. However, in the sole interest of moving this application toward allowance, Applicants have canceled these claims.

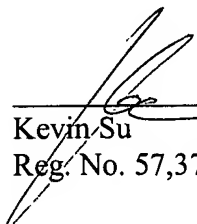
**Conclusion**

Applicants believe that this reply is responsive to each ground of rejection cited by the examiner in the Action dated February 27, 2006, and respectfully requests favorable action in this application.

Please apply any charges, not covered, or credits to deposit account 06-1050.

Respectfully submitted,

Date: 8-28-02

  
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